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COMMITTEE ON THE PEACEFUL
USES OF OUTER SPACE

IMPLEMENTATION OF THE RECOMMENDATIONS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

International cooperation in the peaceful uses of outer space: activities of Member States

Note by the Secretariat

Addendum

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INTRODUCTION

1. In accordance with the recommendations of the Committee on the Peaceful Uses of Outer Space at its fortieth session,[1] Member States have submitted information on the following topics:

(a) Those space activities that were or could be the subject of greater international cooperation, with particular emphasis on the needs of developing countries;

(b) Spin-off benefits of space activities.

2. The information on those topics submitted by Member States as at 31 October 1997 is contained in document A/AC.105/679.

3. The present document contains information on those topics submitted by Member States between 1 November 1997 and 15 January 1998.

Notes

[1] *Official Records of the General Assembly, Fifty-second Session, Supplement No. 20* (A/52/20), para. 163.

REPLIES RECEIVED FROM MEMBER STATES

CHINA

[Original: Chinese]

China's space policy includes the substantial development of applied satellites, accelerating their development process and putting them to widespread use. This conforms to the needs of national economic construction and sustainable social development, creates an environment responsive to the needs of the country and contributes to positive growth. At the same time, it also aims at keeping abreast of international technological advances, facilitating space exploration and research and applying space technology in other technical fields, as well as promoting international cooperation.

A. Satellite applications

1. Remote sensing technology and its application

China's commitment in the field of remote sensing is designed to satisfy the needs of national economic construction. After strenuous efforts during the past two decades, China has increased its application capabilities to serve the needs of national economic construction. A dynamic information service system on resources and environment, with an emphasis on agro-resources, is being developed, using remote sensing data to conduct a nationwide investigation of land resources in an effort to profile China's land resources on a macro scale. In the area of combating natural disasters, a remote sensing system for monitoring and assessing major natural disasters, focusing on flood and drought control has been set up. An aerial remote sensing real-time transmission system has been developed, thus making it possible to transmit real-time images of disaster-stricken areas. During the period 1996-2000, further improvements will be made to the system, which will then be put into service in the relevant departments.

On 10 June 1997, China successfully launched its Fengyun-2 meteorological satellite from the Xichang satellite launching centre, using the Long March-3 launch vehicles. On 17 June, under the control of the land-based monitoring and control station, the satellite was successfully positioned at 105 degrees east longitude over the equator. With an operational life of three years, it provides 100 domestic and 33 international channels for data transmission. This geostationary satellite is able to capture visible light images of clouds, 24-hour infrared images of clouds and pictures of vapour distribution, in addition to being capable of broadcasting climate pictures. The satellite is now operating normally. Its data can be received free of charge in China and by neighbouring countries.

Since 1995, the Chinese Government has organized a number of major research and development projects in response to the urgent needs in the field of resources and environment management. They include:

(a) Remote sensing, Geographic Information System (GIS) and Global Positioning System (GPS) technologies and their comprehensive utilization, featuring dynamic monitoring of land resources and environment, monitoring and assessment of accidental natural disasters, evolving into a practical and operational macro information service system to provide the country with constant macro information on resources and environment and information in support of analysis and decision-making. In the meantime, an operational monitoring and assessment system on major natural disasters has been set up which is able to carry out real-time monitoring on an instant basis in case of major natural disasters of floods, contributing to disaster mitigation and relief and minimization of damages by providing relevant data on disasters. At present, work on information collection, test area selection and system construction is well under way;

(b) Aerial remote sensing real-time transmission systems, designed for the monitoring and assessment of accidental natural disasters such as floods, forest fires and earthquakes. The construction of the systems has been completed and trial operation has begun;

(c) Crop yield estimation by way of remote sensing technology. In terms of yield estimation for staple crops, fields of winter wheat, maize and paddy rice, comprising 85 per cent of total grain output, have been chosen for the work, covering 10 provinces and municipalities. Using the county as the statistical unit, yield estimates at the provincial (or regional) level have been forecasted. The yield estimation accuracy (area and total output) for wheat is above 95 per cent; for maize, above 90 per cent; and for paddy rice, above 85 per cent. Output forecast can be provided 1-2 weeks in advance of harvest. Experiments of yield estimation for wheat and maize in northern China and paddy rice in southern China have been completed. Work on a more extensive application of the technology is in full swing;

(d) Application of remote sensing technology in farmland investigation. Four provinces or autonomous regions—Heilongjiang, Gansu, Nei Mongol and Xinjiang—and a group of agricultural counties have been chosen as test areas for investigation of typological and acreage changes in land;

(e) Development of China's GIS software. Domestic institutions have been called upon in its joint development and evaluation, so as to come up with, and put into widespread use, a package of GIS software under China's own patent;

(f) Remote sensing monitoring of spontaneous ignition in coalfields. Remote sensing and GIS technologies are being used to conduct fundamental surveys of 56 spontaneous ignition spots in coalfields in northern China, including the impact and extent of conflagration etc., with a view to providing a scientific basis for coal fire control and extinction;

(g) Remote sensing monitoring of the marine environment. An all-dimensional marine monitoring system receiving data from satellites, aircraft and land is being developed to monitor environmental elements such as sea temperature, water colour, sea waves, mud and sand suspending in sea water and superficial oil pollution.

At the same time, considerable progress has also been made in remote sensing archaeology, radar application and basic theoretic research.

2. Satellite communication and application

On 12 May 1997, China succeeded in launching its Dongfanghong-3 broadcasting and communication satellite, which was developed exclusively by its own efforts. The satellite, with 24 transponders on board and an operational life of eight years, was positioned on 21 May at 125 degrees east longitude over the sky in the geosynchronous Earth orbit. This satellite, together with the satellite channels currently rented, constitute China's national network of broadcasting, television, telephone and satellite communication, ushering the country's telecommunication industry and its application into a period of modern construction. In the meantime, the setting up of a satellite television network for education has brought remarkable changes to the backward status quo in education and literacy in remote regions. In addition to public networks, rapid advances have also been made in the construction of specialized satellite networks.

In recent years, China has made considerable progress in applying satellite communication technologies in the areas of banking, civil aviation, tele-education via satellite television, petroleum, transportation, water conservancy and power supply. The use of very small aperture terminals (VSAT) has also increased extensively. There are now more than 500 two-way VSAT stations and over 1,000 one-way stations in the country, and the number is growing rapidly. In China, VSAT systems are being used in voice and data transmission, e-mail,

faxes, video-conferencing and dedicated lines of communication. Meanwhile, mobile communication in recent years has found extensive application and received increasing attention, becoming one of the fastest developing fields. China has successfully used VSAT technology in pager relocation and regional networking of mobile communication. The advanced technology has also been used extensively in telephone, live TV broadcasting and emergency communication.

B. Applied satellites

Research and manufacturing of applied satellites is currently one of the fastest developing high-technology fields in China. Intensified efforts are being made to develop the China-Brazil Earth Resources Satellite, a small satellite for observing the colour of ocean water, and the Fengyun-1 polar orbiting satellite. The development of these satellites will substantially enhance China's capabilities in satellite data collection. Meanwhile, ground stations of remote sensing satellites that have already been set up in the country have provided the relevant departments and local governments with a large amount of data for remote sensing applications. Basic research in space applications has also been further enhanced. For example, efforts are being intensified to develop a new generation of high-resolution on-board radar sensors and scientific experimental satellites. The construction of ground systems and preliminary studies are also under way.

In the coming years, China will try to develop small satellites, with an emphasis on small-scale Earth observation satellites.

C. Space research activities

On 20 October 1996, using the LM-2D launch vehicle, China successfully launched the seventeenth recoverable satellite for scientific exploration and technological experiments. Following its successful entry into the intended orbit, all the equipment on board the satellite functioned normally. The satellite was then successfully recovered after 15 days of orbiting in space. Apart from obtaining remote sensing data, experiments in biological development, crop seeds and crystal composition under microgravity and biological tests were carried out using on-board scientific devices.

The agencies concerned continued to carry out space research. In 1997, the Chinese Academy of Sciences completed tests related to the release of balloons in high altitudes and the improvement of monitoring and control equipment. It also continued high-altitude balloon tests, such as atmosphere aerosol tests, solar ultraviolet spectrum tests and hard X-ray astronomic observations. Experiments will be conducted at the Beijing Observatory using its solar magnetic field telescope with high-altitude (above 30 km) balloons.

Scientific research in microgravity with recoverable satellites is also continuing.

D. Launch vehicles

Since April 1970, China has developed and launched over 40 satellites of various categories, successfully launched 10 satellites for foreign clients, undertaken many scientific space explorations and conducted more than 300 on-board experiments in space. A number of important results have been achieved. China's LM-3A launch vehicle is an improvement over the LM-3, with many advanced technologies and its carrying capabilities at geosynchronous Earth orbit having been raised to 2,600 kg. China's more recent development—the LMB-3B—is a tethered three-stage liquid-powered launch vehicle, capable of delivering a 5,000 kg payload of mass into geosynchronous Earth orbit. It represents, for the present time, China's most powerful rocket for launching satellites into geosynchronous transfer orbit. The following are some recent examples of successful launches:

(a) On 3 July 1996, China's LM-3 launch vehicle successfully sent the AP-1A communication satellite into space. Manufactured by the Hughes Company, United States of America, the satellite weighed 1.4 tons, with 24 C-band transponders on board and a designed operational life of 10 years. After finally being positioned at 134 degrees east longitude over the equator, it is providing communication services to the Asian and Pacific region;

(b) On 12 May 1997, a DFH-3 communication satellite developed in China was successfully launched from the Xichang satellite launching centre, using a new type of launch vehicle—the LM-3A;

(c) On 10 June 1997, the LM-3 launch vehicle successfully launched the Fengyun-2 meteorological satellite into orbit from the Xichang satellite launching centre. In the morning of 17 June, the satellite was successfully positioned at 105 degrees east longitude over the equator.

(d) On 20 August 1997, the new launch vehicle, the LM-3B, a product of China's own efforts and the most powerful rocket currently in China, successfully delivered into the intended orbit the Mabuhay satellite, which was manufactured by United States Space Systems/Loral for the Philippines, an indication of the fact that rockets of the LM series are capable of delivering a 5,000 kg payload into high orbit.

E. Space debris

Since becoming a member of the Inter-Agency Coordination Committee on Space Debris in 1995, China's National Space Agency has conducted extensive research on the reduction of space debris, including, *inter alia*, minimizing the generation of space debris through eliminating the potential risks of in-orbit disintegration of the upper stage of the LM-4 launch vehicle and the completion of a three-dimensional vulnerability model structure of spacecraft and an analysis of the extent of risks for the environment of space debris. At the same time, research in the field of space debris monitoring and control is also under way at the relevant institutions.

F. International cooperation

In October 1996, the forty-seventh session of the International Astronautical Federation (IAF) was held in Beijing. It was attended by over 2,000 experts and officials from 54 countries, regions and related international organizations. Events such as major exhibitions and study tours were also arranged during the meeting. China acted as the host and offered conference services. As a practical contribution of China to the programme of peaceful uses of outer space, China covered all the in-session expenses of 29 representatives from developing countries at the United Nations/IAF seminar.

In August 1997, the International Symposium on Geo-information Science and the International Symposium on Geographic Information Systems were held in Beijing. The symposia, which were attended by over 500 representatives from 18 countries, covered geo-information science, scientific forecasting, regional sustainable development, research on global changes and access to geo-information. In addition to academic exchanges and exploring possibilities of cooperative research, demonstrations of GIS technology and presentations on new achievements were held. The symposia contributed to the development of GIS technology and its application.

Since 1995, China has provided 5-7 scholarships each year on remote sensing applications for countries in the Asian and Pacific region, making a valuable contribution to human resources development for developing countries. This initiative will continue in the future.

The Asian Pacific Multilateral Cooperation Initiative on Space Technology and Application, sponsored mainly by China, Pakistan, the Republic of Korea and Thailand, has already made substantive progress. The

countries concerned have reached consensus on an intergovernmental memorandum of understanding on the cooperation project of small multi-task satellites, and intends to initial the instrument at the Fourth Multilateral Cooperation Conference on Space Technology and Application in Asia and the Pacific, to be held in Bahrain in December 1997.

In the field of space technology and application, China has signed a number of bilateral cooperation agreements with other countries, for example, the cooperation agreement between China and Chile; the agreement between China and Brazil on scientific and technological cooperation in peaceful uses of outer space; and the agreement between China and France on cooperation in research and peaceful uses of outer space. At the same time, China has also carried out extensive cooperation in space and remote sensing application with Australia, Italy, Japan, the United States of America, the European Community and the Association of South-East Asian Nations.

LEBANON

[Original: English]

The progression of space-related activities in the economic sector of Lebanon is seriously dependent on the availability and development of the telecommunications infrastructure. This is now a major priority in Lebanon. The value of upcoming telecommunications projects alone, as noted by the Council for Development and Reconstruction, are put at US$ 617 million.

In the research sector, the Lebanese National Centre for Remote Sensing of the National Council for Scientific Research plays a pivotal role in contributing to the development and scientific needs of the country, notably in securing environmental concerns. The Centre also helps decision makers on actions and policies of relevance for the safe use of space, remote sensing and GIS.

The present report on space activities in Lebanon was prepared by the National Council for Scientific Research and is divided in two parts: (a) space-related activities in Lebanese economic sectors; (b) National Centre for Remote Sensing.

A. Space-related activities in the economic sector of Lebanon

As mentioned above, the space-related activities in the economic sector of Lebanon are dependent on the development of the telecommunications infrastructure. The Government has noticed the introduction of television broadcasting, via satellite, in order to diversify and enhance communication with the outside world, as well as the wide expansion of the Internet.

1. Telecommunications sector

Lebanon's authorities concluded that one of the keys to economic resurgence was the rebuilding of the telecommunications infrastructure. The Ministry of Post and Telecommunication is following the improvements being introduced in the satellite Earth stations involving the transition from analogue to digital transmission. There are plans for the installation of new satellite Earth stations in the locality of Jdeide (Beirut). This new installation will double the capacity of international communications. The previous report of Lebanon contained the various projects of the Ministry of Post and Telecommunication and the technical specifications of the five satellite Earth stations installed in Lebanon. These Earth stations transmit through the following satellites: Intelsat, Arabsat (1C, 1D, 2A, 2B), Intersputnik and Eutelsat.

The Lebanon Telecom 97 exhibition was held at Beirut in April 1997. The show provided further evidence of the resurgence of Lebanon in general and its telecommunications industry in particular. This exhibition marks Lebanon's return to telecommunications health.

2. Television broadcasting

The Lebanese Government introduced legislation to control television stations broadcasting to areas outside the country. The authorities delivered permits to two television stations—Future and LBC—to broadcast their programmes through Arabsat and Eutelsat.

In a short time, the two stations have become widespread among the Arab countries.

3. Internet

The Internet is expanding very quickly. In 1997, there are 20 private companies (six in 1996) connecting people in Lebanon to the Internet, using their own Earth stations to establish the communication link with the satellites. In Lebanon, and especially in Beirut, there are currently about 20,000 subscribers (5,000 in 1996).

A symposium on the information superhighway, "Mediacom", was held in Beirut in April 1997. Some 130 speakers from around the world discussed the implications of the Internet on language, education, research and culture in the Mediterranean and in the Arab world.

4. Meteorological information

The Directorate of Climatology of Lebanon has an Earth station to gather analogue images (Wefax format) from climate-related satellites (geostationary satellites). In the coming year, this administration will acquire a new Earth station recording very accurate digital images. The National Council for Scientific Research is cooperating with the Directorate of Climatology to establish a national network of meteorological stations and to assist in the research sectors where climate data are required.

B. National Centre for Remote Sensing

1. Organization structure

The Centre is headed by a director. It follows the Engineering and Technology Division of the National Council for Scientific Research, which reports to the Prime Minister. The Centre has two areas of specialization: sectoral, covering geology, water, agriculture, soil, oceans and the environment; and systems, covering image processing, GIS and shortly GPS.

2. Mission and objectives

The aims of the Centre are as follows:

(a) Cooperating with and assisting public and private sector organizations, institutes etc. in planning and implementing the use of remote sensing and GIS in their operations, with emphasis on environmental concerns;

(b) Securing databases, information, maps etc. from satellite imagery on a timely basis in different areas and disciplines and making the information available, as needs arise, to the private and public sectors;

(c) Interacting and cooperating with remote sensing centres, both regional and international, for the purpose of development, scientific progress and public welfare;

(d) Establishing the needed in-house and field support systems, laboratories and ground evidence for confirmation of remotely sensed data;

(e) Training and capacity-building of personnel for the Centre and other public agencies, and for other purposes as needs arise;

(f) Formulating and advising on actions and policies related to conventions, protocols, agreements or other matters relating to remote sensing with regional and international counterparts or Governments.

3. Services

The Centre has shared and contributed to defining needs where remote sensing is applicable in Lebanon. Similarly, it has assisted other public agencies on relevant matters, notably on the potentials of a centralized GIS.

A number of consultancies have taken shape, notably in designing and implementing projects in the following areas or in formulating actions relating to the availability of data, development and assessment studies, maps, evaluation reports etc.:

(a) Resources: water, soil, iron-ore deposits, construction materials;

(b) Agriculture: land cover and suitability, productivity and yield, rural management, soil conservation;

(c) Environment: land degradation, soil erosion, forestry, biodiversity, coastal deterioration, natural disasters and heritage.

4. Activities

The use of new technologies is essential for supplying and upgrading databases and specific information for the various development sectors in Lebanon. The Centre makes use of the wealth of data supplied from remote sensing platforms, converting, rectifying and processing them as needs arise. The above-mentioned activities are meant to serve the requirements of applied research and researchers, focusing on securing the priority needs of Lebanon. This is in line with serving the community, both public and private, and ensuring full cooperation on different levels. The major activities of the Centre include capacity-building, that is, participating in joint ventures, training, technology transfer, information systems, and attending and participating in scientific meetings. An essential part of the Centre's activities involves ground evidence, verification of material for accuracy and quality, and producing needed documents based on accurate information, both geographically and scientifically, to comply with the wishes of decision makers.

5. Current and future development

Current developments include:

(a) Delineation of natural resources relating to pedology and soil conservation (at the local level, with regional help);

(b) Developing economic potentials of iron-ore deposits lying between the Syrian Arab Republic and Lebanon (at the regional level);

(c) Undertaking thermal infra-red surveys of fresh-water sources in the marine environment (at the regional level);

(d) Application of remote sensing in the Baa'lbek archaeological area (at the local level, with assistance from the Government of Italy and the United Nations Educational, Scientific and Cultural Organization);

(e) Assessment of natural resources in the karstic coastal Mediterranean area (at the international level).

Future developments are as follows:

(a) Water conservation and climate change in degraded lands in the Middle East (at the international level);

(b) Environmental management of fruit and pine forests in the Mediterranean;

(c) Management of torrential floods for resource conservation and soil erosion;

(d) Ecosystem management of the Akkar Nahr El Kabir watershed;

(e) Upgrading and centralization of a public sector GIS;

(f) Assessment of environmental sensitivity and proper land use of coastal urban areas.

6. Cooperation with other organizations

The Centre, through its parent organization the Council for Scientific Research, has cooperative relationships with local, regional and international agencies. Locally, it works with several ministries and/or public agencies and is developing relationships with private universities and other representatives, including industry, transport, construction etc. At the regional level, the Centre has established links with relevant organizations in Egypt, Jordan and the Syrian Arab Republic and is making attempts with other countries. On the international scene, there are several working projects or agreements, such as with the Governments of Canada, France, Germany, Ireland, Italy, Malta and the United Kingdom of Great Britain and Northern Ireland, and the Centre hopes to establish links with others.

7. Fields in which assistance is welcome

In view of the above, the Centre's needs can be summarized as follows:

(a) To train its personnel, on an ongoing basis, on the basic procedures in imagery processing and remote sensing and their applications, including the handling of GIS;

(b) To find mutual benefits in securing equipment or in-kind supplies of equipment;

(c) To build up the Centre's capacities and information resources, establishing a library containing books and journals and in-kind material assistance for relevant support systems.

The Centre is ready to enter into joint-venture projects.

8. Astrophysics

There are plans to develop a network of robotic telescopes in semi-desert countries, from Morocco to the Gobi Desert, that will send stellar observations to all the astrophysical laboratories of the network by way of communications satellites.

An astrophysical laboratory is being established inside the National Council for Scientific Research to participate in the network. One of the aims of the laboratory is to propose scientific research projects.

In Lebanon, only some first-level courses in astrophysics are given by the Faculty of Sciences of the Lebanese University.

There are plans to establish, during the coming year, an astrophysical laboratory (the location has been decided and the road already built), equipped with a robotic telescope. The hydrodynamic astrophysical research can have interesting results.

The study of the system needed to transmit each morning the stellar data obtained during the previous night by each robotic telescope to all the astrophysical laboratories of the network has begun.

REPUBLIC OF KOREA

[Original: English]

Outer space activities in the Republic of Korea in 1996 and 1997 have occurred within the context of major national space programmes and have been marked by notable progress. The Republic of Korea's space programmes include both low Earth orbit (LEO) scientific mission satellite development and geostationary orbit (GEO) communication satellite programmes. They also include an experimental sounding rocket project for which a two-stage sounding rocket was launched successfully using a new launch vehicle system. The country's space activity was also pronounced in other related fields such as domestic space education and research. Owing to the ever-increasing interest in domestic space programmes, the national space budget is also now larger than ever.

The experience and technological progress gained through space activity in 1996 and 1997 have proved highly valuable to the country's future space programmes, providing the basis for their continued progress. Although current activity is still limited, the scale of future space activity is expected to increase. More domestic programmes are planned in parallel with joint international programmes, especially in the next decade. This trend is driven by technological advances in the aerospace industry and the ever-growing demand for higher living standards.

A. Major space programmes

Four major space programmes have been carried out during this period. The first is the Korea Multi-purpose Satellite (KOMPSAT) programme, which was begun in 1994 with the goal of launching the KOMPSAT in 1999. The KOMPSAT is a medium-sized satellite with multiple mission objectives, but whose primary mission is the collection of scientific data through Earth observation. During 1996 and 1997, the design of KOMPSAT was performed in collaboration with the United States spacecraft manufacturer TRW. The KOMPSAT programme is managed primarily by the Korea Aerospace Research Institute and the Ministry of Science and Technology.

Another scientific mission is the KITSAT programme being run by the Satellite Technology Research Centre of the Korea Advanced Institute of Science and Technology (KAIST). KITSAT is a small satellite programme intended to establish spacecraft technology as well as domestic scientific mission capability. KITSAT-I and KITSAT-II were launched in 1992 and 1993, respectively. Various experiments were conducted between 1996 and 1997 using KITSAT-II payloads that include a charge coupled device (CCD) Earth imaging system (CEIS), a low-energy electron detector (LEED) and an infra-red sensor experiment (IREX). The KITSAT-III assembly and test were completed in 1997 and will be ready for launch in 1998.

A third programme, KOREASAT, has produced the first GEO communication satellite of the Republic of Korea, which is now operational at a 116 degrees east longitude geostationary orbit. Significant mission operation experience was accumulated in 1996 and 1997. Mission operation systems were also developed by domestic technology during this period in order to support the KOREASAT satellite operation. As a result, mission operation technology is now at a level sufficient to operate future domestic GEO satellites independently.

Finally, the sounding rocket programme of the Republic of Korea was highlighted by the successful launch of KSR-II, which is a two-stage experimental launch vehicle designed for scientific data collection missions. Although the launch vehicle successfully flew its pre-planned flight path, data collection was unsuccessful owing to a telemetry system failure during its early flight phase. Another KSR-II will be launched in 1998 with the same mission as its predecessor. The sounding rocket programme is expected to evolve into a new advanced launch vehicle development plan. The new programme will start in 1998 with the primary goal of developing the capability of building three-stage medium-range launch vehicles.

B. Low Earth orbit scientific space programmes

Outer space activity by LEO scientific space programmes in 1996 and 1997 mainly centred around a series of experiments conducted by the KITSAT programme. Although implemented at rather basic levels owing to the small size of KITSAT, they still played a leading role in the country's outer space activities during the period 1996-1997.

The LEED experiment was conducted by KITSAT-II at the orbit altitude of 800 km. This experiment uses a 3,000 volt spiral electron multiplier with 16 measurement channels. Data from this experiment have been used for understanding the effects of solar activities on the space environment around Earth.

Also conducted was the IREX, which monitored the effects of the space environment on a KAIST-developed infra-red sensor. Another important experiment, which used a KITSAT-I payload, is the cosmic ray experiment (CRE). This experiment consists of a cosmic particle detector and a total dose measurement detector, which together have 512 measurement channels. Other experiments using the KITSAT programme include testing imaging payloads, communication payloads, digital signal processing devices and on-board computers.

Still under development is the KOMPSAT programme, which, consequently, has not yet been employed on any space missions. The KOMPSAT design was completed in 1997 and a flight module is ready to be assembled in the newly constructed Satellite Integration and Test Centre located at the Korea Aerospace Research Institute. Jointly run by the Institute and TRW, the KOMPSAT programme includes technology transfers, on-the-job training at TRW for Korean engineers and national production of key satellite subsystems. The final on-board payload specifications were also decided in 1997 and are currently being prepared for loading into the flight module. The payload includes an electro-optical camera (EOC), an ocean colour imager (OCI), and a space physics sensor (SPS) for the purposes of cartography, ocean colour monitoring and

space environment monitoring, respectively. The satellite weighs about 500 kg and will be operated on a sun-synchronous orbit at an altitude of 685 km.

EOC has been programmed for a cartographic mission to provide images for the production of scale maps, including digital elevation models of the Republic of Korea from a remote Earth view in the KOMPSAT orbit. EOC is expected to collect panchromatic imagery at a ground sample discrimination (GSD) of 6.6 m and a swath width of 15 km at nadir through the visible spectral band of 510-730 nanometres.

The OCI mission is to conduct worldwide ocean colour monitoring for the study of marine biology. OCI is a multi-spectral imager generating six-colour ocean images with an 800 km swath width and 1 km GSD by the whisk-broom scanning method. Colour images are to be collected through six primary spectral bands centred at 443, 490, 510, 555, 670 and 865 nanometres or six spectral bands selected in the spectral range by ground commands after launch.

SPS consists of a high-energy particle detector (HEPD) and ionosphere measurement sensor (IMS). The mission of HEPD is to characterize the low-altitude high-energy particle environment and to study the effects of a radiation environment on microelectronics. IMS is designed to measure the density and temperature of electrons in the ionosphere.

The data obtained from the KOMPSAT programme will be distributed to various government organizations, research institutes and academic institutes for maximum use. The KOMPSAT programme will begin as scheduled in 1998, for a final launch in 1999. The KOMPSAT programme promises to be a historic landmark in the Republic of Korea's outer space activities.

C. Geostationary orbit communication satellite programmes

KOREASAT F1 and KOREASAT F2 have been operating under the control of two ground stations of the Republic of Korea since the launching of KOREASAT F1 in 1995. The ground stations periodically adjust the orbital locations of these satellites. Ground computer systems are also fully integrated into user-friendly systems. GEO satellite operation technology has advanced to a higher level through the accumulation of experience during 1996 and 1997.

As the Republic of Korea's first GEO communication satellite, KOREASAT is also seen as a turning point for satellite broadcasting over the Korean Peninsula. The KOREASAT programme has also brought significant changes in the area of space engineering during 1996 and 1997. Moreover, it has contributed to establishing the fundamental basis for further national space research activity led by government research institutes and academic organizations. In addition, it has begun to be used in space education at the high-school level since 1997.

Meanwhile, the KOREASAT F3 programme was initiated in 1997 with preliminary design completed the same year. The KOREASAT F3 is expected to be launched into orbit in 1999, replacing KOREASAT F1. The KOREASAT F3 is partly a product of the Korean Industry Participation programme, as some companies of the Republic of Korea are participating in the manufacture of its subsystems. Other domestic GEO satellite programmes have also been announced in 1996 and 1997, and demand for domestic GEO communication satellites is expected to rise in the future. Furthermore, close cooperation between LEO and GEO satellite development programmes is expected as well, in view of the available and other resources.

D. International low Earth orbit communication satellite programmes

Several international LEO communication satellite network development projects saw domestic industry participation in 1996 and 1997. They include GLOBALSTAR, IRIDIUM, ODYSSEY and other multinational LEO satellite communication programmes. Korean companies are involved in building satellite subsystems as well as providing communication services for these projects, enhancing their own space technology level.

E. Space education and research activity

There was also intensive activity in space education and research during 1996 and 1997 in conjunction with the major space programmes. Space education activity focused primarily on university education, workshops and symposia. Space engineering curricula were expanded at the university level. A series of domestic workshops were also held on the subject of space engineering. Space research activity was also naturally active owing to the large-scale space programme activity during this period. Space research consisted of both space mission study, including Earth observation, and satellite engineering. Space research activity is expected to expand in the future in parallel with scientific space programmes planned for the years ahead.

THAILAND

[Original: English]

The space activities carried out by the National Research Council of Thailand (NRCT) are concentrated mainly on remote sensing and are discussed in the sections below.

A. Data reception

Since 1981, NRCT has operated a ground receiving station for acquiring remote sensing data from multi-satellites at the Lad Krabang facility. The station is now capable of receiving data from LANDSAT-TM, SPOT, MOS, JERS, ERS and IRS satellites and will be upgraded for Radarsat and ADEOS data in the near future.

B. Data distribution

At present, the Thailand Remote Sensing Centre (TRSC) has a large archive of satellite data such as LANDSAT-MSS, TM, SPOT, MOS, ERS-1, JERS-1 and NOAA-AVHRR. The following products are available:

(a) Photographic products, both in film and in print, in black and white or in colour, at various scales;

(b) Digital products with the following options: data density of 1,600 bpi or 6,250 bpi on computer compatible and 8 mm cartridge tape.

In 1996, the value of data distributed to both domestic and international users was approximately US$ 1.6 million.

C. Research grant allocation

Each year TRSC offers a grant of 5 million baht to remote sensing application projects proposed by Thai researchers. The grant has been instrumental in promoting the application of satellite technology within the country. In the financial year 1996, there were 11 projects funded under the grant.

D. Education, training and seminars

Most of the universities in Thailand offer a number of remote sensing courses in their curricula. In order to promote the application of remote sensing technology, TRSC offers annual training courses on the principles of remote sensing, digital analysis and geographic information systems for natural resources management to domestic users. In the past few years, TRSC, in cooperation with other agencies, has organized several forums, which were attended by over 1,000 Thai scientists.

E. Research activities

The various government agencies involved in the management of natural resources, including the Department of Forestry, the Department of Land Development, the Office of Agricultural Economics, the Survey Department and the Department of Agriculture, have applied satellite remote sensing in their respective fields.

F. Regional remote sensing promotion centres

To enhance remote sensing activities within the various regions of the country, TRSC initiated a project for the establishment of regional remote sensing promotion centres, in collaboration with the universities of each region: northern, southern and north-eastern. The objective is to develop remote sensing courses and research activities in the regional universities. The centres also act as a core agency for remote sensing technology transfer and data distribution at the regional level and could perhaps be extended to neighbouring countries. As a core agency in the region, as well as with neighbouring countries, the centres are responsible for remote sensing activities such as developing study and training programmes, distributing satellite data to local users and supporting and promoting research activities.

G. Seawatch Thailand

Seawatch Thailand, a marine surveillance and information system, is a marine environmental monitoring and forecasting system that integrates data collection and analysis, environmental modelling and forecasting with an advanced computerized system for the distribution of marine information and forecasts to interested operators and/or authorities. The project is being implemented under close cooperation between NRCT and the Oceanographic Company of Norway AS (OCEANOR) and other relevant parties, including the Harbor Department, the Meteorological Department, the Port Authority of Thailand, the Naval Hydrographic Department, the Department of Fisheries, the Petroleum Authority of Thailand, the Marine Police Division, Chulalongkorn University, Kasetsart University, Prince of Songkhla University and Burapha University.

The objectives of the Seawatch programme are as follows:

(a) To set up a marine database using the technological integration of remote sensing, the buoy network and meteorology;

(b) To archive and distribute marine data and information to relevant offices in both governmental and private sectors for use in national resources development and management;

(c) To coordinate and work with other offices in studies and research in the field of oceanography and marine resources;

(d) To coordinate and work with relevant offices in the utilization of marine data and information in national resources planning, development and preservation;

(e) To distribute knowledge and technology of the use of marine data and information for the development and management of national resources.

H. Remote sensing small satellite programme

The preparation and execution phases of the programme consist of the following:

(a) *Establishment of the remote sensing small satellite (RSSS) programme office*. The programme office has been established under NRCT;

(b) *Preliminary systems definition phase*. Most requirements and definitions are defined from the results derived from user and application needs;

(c) *Systems design phase*. This phase immediately follows the preliminary systems definition phase, once the funding arrangement has been approved by the Government of Thailand;

(d) *Systems development phase*. This phase commences concurrently with the previous phase but has a longer duration of about 36-40 months after contract signing with the programme's primary contractor;

(e) *Systems operational phase*. This phase will start after the RSSS has been successfully launched and all early orbit control and testing are completed. The phase will last at least five years (the design life of the satellites), until the end of the life of the satellite.

I. International cooperation in remote sensing and space technology

The NRCT cooperates with countries and organizations in the region as well as outside the region for the development of remote sensing technology. Cooperating countries and organizations include Australia, Canada, China, Japan, France and the United States, in addition to ASEAN, the Economic and Social Commission for Asia and the Pacific and other United Nations organs. Areas of cooperation relate to joint research technical development and human resources development.

An example of such cooperation involves the NRCT-National Space Development Agency of Japan (NASDA) pilot project. The five-year data utilization programme began in 1997 and will run until March 2002. Participating agencies are NASDA and the Remote Sensing Technology Centre (Japan) and NRCT, the Department of Town and Country Planning, the Office of Agricultural Econon cs, the Department of Land Development and the Department of Fisheries (Thailand).

J. Conclusions

The present report demonstrates the capabilities and experiences of Thailand in the area of remote sensing in the space programme that fall mainly under the responsibility of the National Research Council of Thailand, Ministry of Science, Technology and Environment. However, NRCT is not the only government organization that is responsible for the space programme.

The RSSS programme is a new programme that is to be approved by the Government in its multi-year programme budget. The programme and its preparation work are well in progress, and RSSS will be launched into orbit within three years after contract signing with a primary contractor. Through NRCT, Thailand will be operating the first remote sensing and environmental satellite system for monitoring the country's natural resources and environment. Thailand will be joining the technologically advanced countries in the space league

and will, in the near future, have the scientific and technological capabilities of working in space, on Earth's land resources, in the environment and in the oceans.

TURKEY

[Original: English]

The Coordinating Committee on Space Sciences and Technologies (UBITEK) was established in Turkey in 1992. Its activities were supplemented by the United Nations Development Programme (UNDP) and the United Nations Industrial Development Organization (UNIDO) and funded mainly by the Turkish Government. Within the National Research Council (TUBITAK)/Marmara Research Centre (MRC), at Gebze-Kocaeli, a Space Sciences Department (later known as the Space Technologies Department) was also established to provide the technical and administrative consultancy and secretarial work that was needed for the activities of UBITEK. The Committee has undertaken an implementation programme, with special attention given to the following main areas.

A. Space and airborne remote sensing

A well-equipped Remote Sensing and Image Processing Laboratory (UZALGIL) is now functioning within the Space Technologies Department of the Marmara Research Centre. The needs of the Laboratory, such as hardware, software and personnel, are provided through the UNIDO project and local TUBITAK funds. Grain acreage by remote sensing and erosion mapping by remote sensing and geographic information systems, which are two national projects, and the new MOMS-2 sensors in use for environmental applications in Turkey, an international project that is being carried out in collaboration with the Government of Germany, are being implemented in the same laboratory. A World Bank project on micro-catchment rehabilitation in eastern Anatolia will also be implemented by remote sensing and GIS techniques from UZALGIL.

The establishment of a ground receiving station for data from super-high-resolution remote sensing satellites (ground discrimination of 1-3 m) is being discussed by an ad hoc committee established by the Prime Minister's Office and the corresponding satellite companies.

The Foundation for Combating Erosion (TEMA), located in Istanbul, is a non-governmental organization involved with space activities. It uses space technology to assist in the solution of problems of regional or global significance. Among its activities are the following:

(a) Increasing awareness against the dangers of desertification in the country;

(b) Supporting and financing technical practical projects that use satellite remote sensing technologies in assessing the actual and potential risk of erosion and desertification.

TEMA also financed a pilot project prepared by TUBITAK in a watershed area in western Turkey (Dalaman River).

B. Microwave technologies for use in remote sensing and space observations

A Radiophysics and Antenna Laboratory (RAL) has also been established through the national space programme. Current activities include design, production and application of various microwave and millimetre wave instrumentations and techniques, for example, scatterometer, radiometer, Doppler radar, a millimetre waves radio telescope, sensitive radio receivers—design and component productions—basic element and

material studies for vegetation canopy modelling and millimetre wave tomography. A new objective of RAL is to investigate new radio techniques to find and locate anti-personnel landmines.

C. Radio astronomy

Design and implementation of a two-metre radio telescope, working in the millimetre wavelengths, have been planned in cooperation with the Ukrainian Academy of Sciences Institute of Radio Astronomy (RIAN) at Kharkov. As of May 1995, the instrument (dubbed as a 2 m sized Marmara telescope (MRT-2) has been erected at Gebze-Kocaeli, Turkey. Its calibration is being executed in cooperation with RIAN and the University of Illinois Department of Astronomy, at Urbana, Illinois. The use of the instrument for the study of molecular clouds in the Milky Way and observations of the Sun and planets at millimetre wavelengths are planned by MRC, in cooperation with various national and international research groups. The first ozone line measurements were successfully carried out in the spring of 1997 and their results have been published.

D. Optical and space-based astronomy

TUBITAK established the Institute of Optical Observatory in the western Taurus Mountains. Other countries, such as the Netherlands and the Russian Federation, also contributed optical telescopes and related observational and other instruments. The site has excellent observing conditions (elevation of 2,500 m). Other countries and groups are encouraged to participate and include their instruments to help to enlarge the international scientific research centre around the seed observatory. An official opening ceremony for the observatory site, which was attended by the President and Prime Minister of Turkey, the Director of the Space Research Institute of Moscow and the Rector of the Kazan University, took place on 5 September 1997.

Since Turkey will be one of the best sites to observe the last solar eclipse of the millennium, which is to take place on 11 August 1999, preparations have begun to accommodate large numbers of visitors to the sites where the total eclipse will be observed by departments of physics, astronomy and space science of Turkish universities.

Turkey is also participating in the X-ray astronomy satellite experiment, known as Spectrum X-Gamma, under the coordination and leadership of the Russian Federation's Space Research Institute. There is also a strong European commitment and contribution to the complex of the X-ray satellite, which is being integrated and calibrated; the launching date has been postponed from 1996 to 1998.

E. Establishment of space-related education activities

The TUBITAK/Marmara Research Centre at Gebze-Kocaeli is making preparations for the Marmara Institute of Space Research and Education. It will be the core Turkish institute in the central and south-eastern European network of space research and educational institutions, proposed recently by the Committee on the Peaceful Uses of Outer Space. It will concentrate on such areas as satellite remote sensing and radio astronomy.

The Centre for Air and Space Research (HUZAM) of the Istanbul Technical University was established in 1995. The Centre is designed to provide education and the promotion of satellite communication, remote sensing and related technologies. Several other universities have also established research centres in the area of space science and technologies. Among them are the University of Cukurova at Adana and the Anatolian University at Eskisehir.

F. Other activities

A third satellite, in addition to the existing Turkish Communication Satellite System (TURKSAT), is under onsideration by Turk-Telecom. The TURKSAT system is currently providing communication and television nks in western Europe, Turkey and the central Asian republics.

Also, at least two institutions are involved in preparations for a mini/micro-satellite programme:

TUBITAK-MRC has negotiated with a corresponding group in the Russian Federation for a joint small remote sensing satellite. Funding through the Black Sea Economic Cooperative or other organizations is under consideration;

A group at the Middle East Technical University is considering building a micro-satellite for remote sensing, in cooperation with a partner in the United Kingdom of Great Britain and Northern Ireland.

These are some of the activities undertaken by Turkey in various areas to promote sustainable evelopment, to address issues related to education and technical assistance in space science and technology nd to strengthen international cooperation.

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IMPLEMENTATION OF THE RECOMMENDATIONS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

International cooperation in the peaceful uses of outer space: activities of Member States

Note by the Secretariat

Addendum

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INTRODUCTION

1. In accordance with the recommendation of the Committee on the Peaceful Uses of Outer Space at its fortieth session,[1] Member States have submitted information on the following topics:

(a) Those space activities that were or could be the subject of greater international cooperation, with particular emphasis on the needs of developing countries;

(b) Spin-off benefits of space activities.

2. The information on those topics submitted by Member States as at 31 October 1997 is contained in document A/AC.105/679 and the information submitted as at 15 January 1998 is contained in document A/AC.105/679/Add.1.

3. The present document contains information on those topics submitted by Member States between 15 and 21 January 1998.

Notes

[1] *Official Records of the General Assembly, Fifty-second Session, Supplement No. 20* (A/52/20), para. 163.

REPLIES RECEIVED FROM MEMBER STATES

FRANCE

[Original: French]

The launching of the first Earth satellite on 4 October 1957 heralded the beginning of a new era, that of space. In 1962, the National Centre for Space Studies (CNES) was set up and the foundations of the French space industry were laid. On 26 November 1965, Asterix, the first French satellite, was launched and within several decades space activities gained a place in the world, calling for considerable stakes in the industry, research, culture and defence sectors.

For CNES, the year 1996 was marked by the preparation of a strategic plan representing a basis for the activities to come. CNES adopted a strong dynamic approach enabling its activity to be part of the world evolution within the space context.

A. Strategic plan of the National Centre for Space Studies

The important changes taking place at the end of the century affect in particular the space sector, which, by nature, is located at the intersection of scientific, technological, economic and political stakes. Thus, along with developments corresponding to a new geopolitical order, such as the international space station, or to an awareness of global problems, such as space systems devoted to the study of climatic and environmental changes, there now appears to be a large amount of activity associated with the onset of growing markets for space applications, such as those relating to society's need for information.

This development has already changed, probably on a long-term basis, the behaviour of certain space Powers such as Japan and the United States of America. In addition to their traditional role involving substantial programmes remote from the market, these States now consider it necessary to promote the competitiveness of their space industry, a necessary stage in increasing employment in an advanced and innovative sector.

To enable Europe to remain a space Power of the first order, the countries of Europe must in turn adapt to this development. France, which plans to remain one of the promoters of European space activities, has a major role to play in this undertaking. CNES has adopted a policy of strategic thinking so as to enable France to find its place in the major international programmes in order to retain a higher-calibre scientific community and to have a competitive space industry capable of meeting the growing demands of space users.

This plan should be reflected in the operational sense by the medium-term programming of its relations with industry and with its institutional partners.

B. Main aspects of French space policy in 1996

The Ariane 5 programme is a fundamental unit for European cooperation since it makes it possible for Europe to maintain a strong position on the satellite launching market. The successful launching of the second test flight in October 1997 has made it possible to continue the work for operational testing of the launcher during 1998.

The operation of the Hélios 1A satellite, launched in July 1995, has continued successfully. In parallel, the trials with the Hélios 1B satellite have proceeded in a satisfactory manner and have led to its acceptance, its launching being planned for 1999. Its design is identical to that of Hélios 1A, but it possesses a semiconductor

mass memory, which will improve its operational capabilities. The Hélios 2 satellite is at present at the development stage.

The French space industry covers launchers, telecommunications, Earth observation and military space. The companies working in these fields are mainly located in the Midi-Pyrenean area; they employ almost half of the personnel concerned with the space sector.

As part of the research and development plan for 1996, stress has been placed on the technologies going into the design of vehicles and payloads and the improvement of systems and equipment and on methods of managing programmes in order to optimize the partnership between public research and industry.

C. Industrial activity

Since its creation, CNES has been seeking to promote an industrial potential geared towards space activity, its aims being to ensure the continuation of existing competencies, the capacity to meet needs and the possibility of facing international competition and ensuring the profitability of public investments.

1. Aérospatiale

Aérospatiale is the industrial architect of the Ariane 4 and Ariane 5 programmes. In this capacity, it is conducting studies and tests on systems and building the first and third stages of Ariane 4, as well as the principal cryogenic stage and the power acceleration stages of Ariane 5. It performs mission analyses for each launching, provides flight schedules and processes the flight data.

Aérospatiale is developing the atmospheric re-entry demonstrator (ARD), which is an automated capsule that makes it possible to test re-entry materials as well as landing and recovery systems. The company is the contractor for the development of the automatic transport vehicle (ATV) for servicing the international space station and is studying, within the framework of a European economic interest group, the crew transport vehicle (CTV) for the European Space Agency (ESA). It is also the contractor for several telecommunications satellites: ARABSAT 2 (Arab League), Turksat (Turkey), Nahuel (Argentina), ThaVcom 3 (Thailand), Agila (Philippines), Sirius 2 (Sweden), Eutelsat 3 (W 24) and Sinosat (China). It also constructs the Météosat (Eumetsat) meteorological satellites, the Infrared Space Observatory (ISO) infra-red astronomy satellite and the Huygens interplanetary probe, which is due to land on Titan (ESA missions).

Aérospatiale has been selected by CNES for the development in partnership of a small multi-mission platform (Proteus). The first application will involve the Jason satellite, successor to Topex-Poseidon. It is also constructing for CNES the platform for the Stentor experimental satellite and the Vegetation payload for SPOT 4.

Furthermore, Aérospatiale is participating as a major partner in the construction of the Globalstar satellites. It is also collaborating in the Medsat initiative, aimed at promoting satellite services for the countries of the Mediterranean Basin. Finally, in 1997, it set up a subsidiary organization called Aérospatiale Multicom for high-output satellite transmissions.

2. Alcatel Espace

As a subsidiary of Alcatel, Alcatel Espace occupies an important place in the field of satellite telecommunications systems and telecommunications payloads.

Alcatel Espace is the promoter of the SkyBridge system, a network for wide-band access for interactive multimedia services, using a constellation of 64 low-orbit satellites. SkyBridge will have world coverage and

will permit services such as the Internet at a very high speed, telecommuting, tele-education, teletherapy and all types of on-line services and free-time activities. This constellation will be put into operation in the year 2001. Loral Space and Communications (United States of America), Toshiba, Mitsubishi and Sharp (Japan), Aérospatiale (France), SPAR (Canada) and the Regional Investment Company of Wallonia are the main partners so far.

Alcatel Espace is the contractor for the World Space system, the first system for digital broadcasting by satellite, built for World Space Inc. (United States). The World Space system will be operational at the beginning of 1999.

Besides the major communications companies, Alcatel Espace is a strategic partner of the Globalstar system, a new world system for mobile telephony to be put into service in 1999. In 1996, Alcatel Espace was selected to make the payloads of the following telecommunications satellites:

M2A, with Loral/Space Systems—high-output digital telecommunications (Indonesia);

Intelsat IX, with Loral/Space Systems—telecommunications (Intelsat International Organization);

Express A, with NPO PM—telecommunications (Russian Federation);

Hispasat 3, with Aérospatiale—telecommunications and television (Spain).

Alcatel Espace will construct the Poseidon II radar altimeter for Jason, a joint mission of CNES and the National Aeronautics and Space Administration (NASA).

3. Arianespace

In accordance with its development plan, this company has continued to adapt its full space transport service to meet the changes in the requirements of its clients. At the end of 1996, the contracts signed covered more than 40 satellites that were to be launched.

As far as Ariane 4 is concerned, the activity in 1996 was continued, with 10 launchings in 11 months; this has made it possible to place 15 satellites in orbit. In order to meet the demand, an additional order for 10 Ariane 4 satellites has been decided on, bringing to 33 the number of launchers of this type in production.

Arianespace has continued its work for the coming operation of the new launcher Ariane 5 and has undertaken studies for its further improvement, especially for increasing its efficiency so as to meet future needs. An initial order for 14 Ariane 5 satellites has been signed.

Furthermore, Arianespace has extended the services offered to clients by setting up the Arianespace Finance Company and has broadened its international presence by opening a commercial enterprise in Singapore that will cater for the south-east Asian market.

4. Matra Marconi Space

In the field of Earth observation, Matra Marconi Space is the contractor for the SPOT satellites (SPOT 4 will be launched in 1998 and SPOT 5 is currently being developed) under the CNES programme for Helios military satellites intended for the General Armaments Office. Matra Marconi Space constructs more than 50 per cent of the radar satellites for the European Space Agency (RES 1 and RES 2 are operational and Envisat

will be launched in 1999), including the platform, the synthetic aperture radar and the instruments for measuring atmospheric ozone, and the microwave radiometers.

In the field of meteorology, Matra Marconi Space is constructing the instrumentation for the Meteosat satellites and will be the contractor for the Metop satellite intended for the European Meteorological Organization (Eumetsat), the development of which is being carried out by ESA.

Matra Marconi Space is developing a line in platforms for future low-orbit missions (Leostar), to be used in minisatellites (up to 1 tonne).

In the telecommunications field, Matra Marconi Space is the contractor for the following programmes: Silex (Optical Intersatellite Liaison System—ESA/CNES); Hot Bird (Eutelsat); Skynet D, Skynet E and Skynet F (United Kingdom of Great Britain and Northern Ireland); Nileset (Egypt); ST 1 (Singapore and Taiwan Province of China); Astra 2 (Luxembourg); Intelsat KTV and Nato 4 (North Atlantic Treaty Organization).

In addition, Matra Marconi Space is taking part in the Inmarsat 3 and Koreasat programmes as the payload contractor.

5. Société européenne de propulsion

For the Société européenne de propulsion (SEP), the leading European company in the field of space propulsion, the main civilian activity concerns the Ariane 4 and Ariane 5 launchers. The production of the Ariane 4 engines continued at a steady rate. Moreover, the Vulcan cryogenic engine designed for the second Ariane 5 flight has been delivered, along with the nozzles for the solid propergol engines. The development work on the improved version of Vulcan 2 has continued.

SEP has also delivered to Pratt and Whitney the first carbon-carbon divergent nozzle intended for the RL10 cryogenic engine and the tests in 1997 were highly satisfactory.

SEP has continued to cooperate in the matter of the cryogenic engine with the Russian company CADB, as well as continuing its work on plasma propulsion for satellites. An engine of this type, called PPS 1350, will be used in the CNES Stentor satellite.

Finally, SEP is continuing to introduce into the market drive mechanisms for the solar panels used for geo-stationary satellites. In the case of low-level liquid propulsion for satellites, it has made plans to cooperate with Brazil.

6. SPOT Image

SPOT Image, which has been commercially operating SPOT satellites for more than 10 years, has become a world leader on the market for geographical information stemming from satellite imaging. Because of its knowledge of implementation needs, its means and its resources for this purpose, SPOT Image has succeeded in gaining 60 per cent of this emerging market. The commercial network of SPOT Image and its subsidiaries (Australia, Singapore and United States) is spread over the five continents and reinforces the presence of the company at the world level.

The SPOT system offers a complete operational service: reception, processing and commercial distribution of data. Thanks to the SPOT 4 and SPOT 5 satellites, each of which will contain technological innovations, the continuity of the service for users is guaranteed well beyond the year 2000.

SPOT Image, through its contact with users, has the benefit of the experience gained since the launching of the first satellite, in 1986. The company meets the multiple demands of the market through a broad range of products that are adapted to the emerging applications. The geographical data provided by SPOT images are accurate, up to date and objective; they are of value to many users (public services, managers, decision makers and planners) and have a great variety of applications (cartography, geographical data systems, agriculture, town or country planning). SPOT Image markets standard products, value-added products and turnkey projects, in which it plays the part of designer, product and service integrator and contractor. Access to the imaging still remains one of the company's main concerns: the Dali catalogue accessible by Internet contains references to more than 5 million images and a catalogue of the products will be placed on the Internet at the beginning of 1998.

D. Activities conducted in France

The activities conducted under the national programme and as part of France's participation in the ESA programmes are as follows:

1. Access to space

The launchers

Ariane is a product of the experience acquired through the development of ballistic missile stages of the deterrent force, and then those of the Diamant launcher. Today, Arianespace markets and provides launching services for the Ariane 4 version, which is capable of launching 4.2 tonnes into a geostationary transfer orbit for the most advanced configuration.

The success of the programme and the trends in the market have reinforced the will of the European States to develop Ariane 5, which, when tested, will be a launcher offering a high quality to cost ratio. The first test launching took place on 4 June 1996. The origin of the failure of that launching was an error in the design of the internal software of the inertial reference system. Following the recommendations made by the board of inquiry set up after the failure, action was taken to review all the launcher systems. The second test launching, on 30 October 1997, was successful. The data transmitted by the launcher show that the propulsion, trajectory and timing of the stage separation were nominal. The third and final test launch is scheduled for the middle of 1998.

The further development of this launcher is a necessity for maintaining its competitiveness. The Ariane 5 development programme meets this need. The launcher will be capable of placing 7.4 tonnes into a transfer orbit, as opposed to 6 tonnes in the present version.

International space station

At the last ministerial meeting of the ESA Council, in October 1995, it was decided that Europe would take part in the future international space station. The principal unit to be provided by Europe will be the laboratory known as the Columbus Orbital Facility (COF), which will be put into service in 2003, and not 2002, because of a delay in the construction of the service module.

Balloons

These are space vehicles that represent an original means of observation at altitudes ranging from 15,000 to 45,000 m. They are a necessary addition to the observation programmes for satellites. Two important scientific experiments were successfully carried out in 1996:

Interboa. The campaign was developed in August 1996. Three balloons were launched from the Esrange base in Sweden. The programme was carried out in collaboration with the Radiation Space Studies Centre of the National Centre for Scientific Research (CNRS), the University of Washington at Seattle (United States), and the Polar Geophysical Institute at Apatity (Russian Federation). The scientific objective was the study in the polar region of the ionospheric-magnetospheric coupling by correlation of measurements made in a balloon at an altitude of 35 km by satellite and by ground radar;

Pronaos. This relates to a submillimetric astronomical observatory, weighing 2.9 tonnes, proposed by the CNRS laboratories and developed with CNES as contractor; it consists of a telescope, 2 m in diameter, which was launched by NASA, using a CNES stratospheric balloon (altitude of 35 km) from Fort Sumner in the United States. Several interstellar clouds have been observed and the presence of the condensation of very cold interstellar matter unknown so far has been revealed.

Proteus platform

The Proteus (reconfigurable platform for observation of the Earth, telecommunications and scientific uses) programme will make it possible by the year 2000 to have a platform for satellites weighing 300-500 kg adapted to circular orbits between 400 and 1,500 km, together with its ground component. The platform will offer major advantages, such as reduced costs, shortened deadlines, optimal orbit, continuity of service and the possibility of rapidly testing out new concepts while in orbit.

This programme has involved a partnership with Aérospatiale, and an integrated CNES/Aérospatiale team has been put together.

The first programme that can benefit from Proteus is Jason, an altimetric satellite that will be carried out in cooperation with the United States. This satellite will succeed Topex-Poseidon, launched in 1992, and should be operational by the middle of the year 2000. The second programme is to be the Corot (a mission for astroseismology and extrasolar planetary research around nearby stars).

2. Earth observation

The SPOT observation satellites provide a large quantity of information in such varied fields as climatology, agriculture, natural phenomena, natural resources, cartography and land planning. The importance and diversity of these programmes make France a pioneer in the field. Furthermore, since 1992, the data furnished by Topex-Poseidon have permitted better understanding of oceanic circulation and changes in the climate.

SPOT

Manufactured in collaboration with Belgium and Sweden, the SPOT system has been operational since 1996. The third satellite of the series, placed in orbit in September 1993, suffered a breakdown in the attitude control system that has made it unusable since November 1996. The nominal lifetime of these satellites is three years. In order to continue providing a fully operational service, SPOT 1 and SPOT 2 are used in direct transmission mode. The launch date for SPOT 4 has been advanced to the first quarter of 1998.

SPOT 4 will provide continuity of the system up to the beginning of the year 2000. Its capabilities will be enhanced to a considerable extent as compared with those of its predecessors because of the addition of a new spectral band in the infra-red area, which will be useful for the observation of vegetation. In addition, it will include an instrument (Vegetation) permitting daily observation of the continental biosphere by means of a broad visual field (2,000 km) and a resolution of 1 km. SPOT 4 will have a solid-state memory of 10 gigabits, which will improve the reliability of its recording systems. Vegetation has been co-financed by Belgium,

France, Italy and Sweden, together with the European Union. The instrument will bring about definite progress as compared with the other systems.

It will contain three other instruments as well:

Pastec (technological passenger) for studying the orbital environment;

Pastel (passenger SPOT telecommunications laser) for transmitting high-output images through an optical link with the data relay satellite;

Doris, for determining with precision the satellite orbit in order to be able to provide superimposed photographs.

France has decided to undertake the SPOT 5 programme, which will make it possible to ensure the continuation of the system beyond the year 2000. Several improvements have been decided on, the most important one concerning the resolution on the ground, which will be finer (3 m instead of 10 m in the panchromatic mode, and 10 m instead of 20 m in the multispectral mode).

Topex-Poseidon

The aims of this Franco-American mission have been broadly fulfilled and remarkable scientific results have been obtained in several areas: the mean oceanic circulation has been quantified, seasonal effects and interannual anomalies of the El Niño type have been observed, ocean waves moving from east to west have been traced and described, and the tide models have been, to a large extent, improved. The data obtained have been a major contribution, in conjunction with those provided by ERS, to improving the marine geoid.

Bearing in mind these results, the need to follow up this programme was clear and, in December 1996, an agreement between CNES and NASA was signed. Jason will be the name of this new mission. CNES will provide the altimeter and the Doris system, while NASA will supply the radiometer, the laser reflector and the positioning system. The payload will be installed on the Proteus platform (see above).

Scarab

This programme, undertaken in collaboration with Germany and the Russian Federation, is aimed at monitoring the terrestrial radiation balance. The first instrument, mounted on the Russian satellite Meteor 3 and launched in January 1994, functioned for 13 months. The data obtained were distributed to scientists for their use. The second flight model should have been launched with the Russian satellite Resurs in June 1997, but the launching has been put off until the first half of 1998.

Polder

The Polder imaging polarization reflectance radiometer, intended to collect information on the visible radiation reflected by clouds, aerosols and marine and continental surfaces, was the first joint effort between Japan and France in the area of Earth observation. It was part of the payload of the Adeos satellite of the National Space Development Agency (NASDA) of Japan, which was launched successfully in August 1996. This satellite stopped functioning in June 1997. The data acquired over eight months have been processed at the Toulouse Space Centre and are now being distributed.

IASI (infra-red atmospheric sounder instrument)

This new instrument for meteorology is the most important part of the payload in the meteorological satellites of the Metop series. This satellite, the first model of which is to be launched in 2002 or 2003, will be inserted into a polar orbit.

The probe is necessary for progress in the digital prediction of time and the study of the climate. Its spectral and radiometric performance will permit the observation of temperature and humidity profiles in the troposphere with an accuracy and vertical resolution unobtainable with the present operational probes, and access to measurements of the integral gas contents, such as ozone, methane and carbon monoxide, that play a key role in the additional greenhouse effect.

Development up to the definition phase has been carried out by CNES. The development phase has been the subject of a cooperation agreement with Eumetsat to provide the first flight model and two additional models for Metop 2 and Metop 3.

3. Telecommunications

As the most important area in the commercial applications of space, space telecommunications represent high economic, political, cultural, strategic and industrial stakes. This sector, especially that of the satellites in geostationary orbit, represents for the moment the essential segment of the market for the Ariane launcher.

In the future, satellites will be called on to play a major role, whether in the matter of television broadcasting or mobile telephony, with personal satellite communication systems having world coverage.

The liberalization of telecommunications in Europe with effect from 1 January 1998 has led traditional operators to refocus on their activities. In the case of France, the France Télécom Research Centre (CNET) is responsible for research into future telecommunications programmes, while CNES prepares and supports the research and development activities in the field of space telecommunications, with the aim of cooperation and partnership with industry.

In August 1996, the telecommunications satellite Telecom 2D was successfully put into orbit by Ariane. This satellite, the fourth in the series, was constructed by Matra Marconi Space and Alcatel Espace was a co-contractor. CNES, which placed it in position, is in charge of keeping it in position and controlling it in orbit.

In the field of telecommunications satellites, French industry is having to face up to rapid progress in technologies and the needs of the market within a highly competitive environment. Aware of the extent of the stakes involved, the French Armaments Office (DGA), France Télécom, CNES and the industrial contractors (Matra Marconi Space, Aérospatiale and Alcatel Espace) have pooled their efforts to propose a technological programme able to enhance the competitiveness of the French industrial firms. This programme, which was agreed to in October 1994, covers research and development activities, ground developments, a satellite (Stentor) and the incorporation of new technologies validated by the programme into industrial product lines.

Stentor will have a mass of 2,000 kg, with an electrical output of 2,400 W and a lifetime of nine years.

4. Location

COSPAS-SARSAT

This programme is intended to aid research and rescue all over the world. An agreement was signed in 1988 between the four founding countries (Canada, France, Russian Federation and the United States) to provide the space equipment. By the end of 1996, 24 countries had undertaken to provide the ground component. In France, CNES, aided by user administrations, is operating the reception station and the mission control centre, located at Toulouse.

So far, the service has been provided from five International Search and Rescue Satellite System (COSPAS-SARSAT) satellites: three satellites using a United States National Oceanic and Atmospheric Administration (NOAA) platform and Canadian and French payloads and two satellites supplied by the Russian Federation.

Argos

Intended mainly for study and the protection of the environment, the Argos system contains a space component made up of data-collection instruments and locating devices provided by France and incorporated into the American polar satellites (NOAA) for meteorology. In 1996, the number of beacons using this system was more than 9,000 and it is growing steadily.

The NOAA-K satellite, the launching of which was scheduled for August 1997, will now be launched in 1998. It will carry the first Argos payload (Argos 2) of the second generation, which will offer a greater capacity and enhanced sensitivity. Three other NOAA satellites equipped with the same instrumentation will be launched later on.

CNES and NASDA are collaborating to equip the Adeos 2 satellite with an Argos instrument that has new functions making it possible for users to conduct a dialogue with their beacons. The identification model was successfully tested in November 1996. This instrument (Argos 3) could also be used for Metop satellites. Discussions are under way with Eumetsat on this point.

5. Navigation

The satellite navigation systems will make it possible to provide the services needed for the navigation of civil aircraft. It will then be possible to do without a complex and costly ground infrastructure that does not guarantee the sufficient coverage of needs. Designed to supplement the American Global Positioning System (GPS), the European programme known as the Global Navigation Satellite System (GNSS-1) will enable aeronautical needs to be met. This programme has been coordinated by the tripartite group made up of the European Union, ESA and Eurocontrol.

The Council of the European Union adopted a resolution on 19 December 1994 on the European contribution to the establishment of a global satellite navigation system. An initial European draft plan of action on the subject of satellite navigation was submitted in May to member States. For its part, in line with the project proposed within ESA, the Eurocontrol Management Committee adopted a strategy for using satellite navigation systems with, as the final aim, the installation of a single navigation system for all the phases of the flight.

ESA has included a navigation programme within the framework of the advanced research and telecommunications systems (ARTES) programme. It includes chiefly the development of the European

pre-operational system (GNSS-1) in Europe. This programme was unanimously adopted by member States in December 1994. CNES has been taking part in the ARTES programmes since February 1995.

Set up in Toulouse at the site of CNES, the joint team for the ESA project includes personnel from several participating countries with staff from CNES and the Civil Aviation Office (DGAC).

At the industrial level, the European team built up around Thomson-Csf, the system contractor, has made progress in defining architecture systems for the pre-operational and operational phases.

The system will make it possible for aircraft to navigate along oceanic and continental routes and to improve the conditions for the approach and landing stages. It will be possible to reduce the spacing in the aerial corridors and trajectories will be optimized.

6. Exploration of the universe

Scientific space programmes traditionally involve a balance between three lines of research—astronomy and astrophysics, exploration of the solar system and the physics of space plasmas. Besides this, new areas have emerged, such as basic physics and exobiology.

A large part of the French activity is conducted through the ESA scientific programmes.

At the national level, a programme has been prepared for scientific missions using light satellites. The first such mission will be Corot, which is an experiment in astroseismology aimed at measuring the frequencies, amplitudes and widths of natural oscillation modes of stars. It will make use of the Proteus platform.

Half-way between the satellite and the balloon (see section D, above), Pronaos is a submillimetric astronomy project, the last area not yet covered by the observations. This area is located between the distant infra-red already observed by the satellites and the millimetric area, the study of which is possible using ground telescopes. The programme relates to the study of cold objects such as planets, comets or cold clouds, the physics of interstellar space, the physiochemistry of interstellar dust, the formation of stars, the variation from one galaxy to another and the study of the primitive evolution of the galaxies.

Cooperation

France is making a contribution to the Odin scientific satellite developed by Sweden and intended for the observation of the as yet unstudied electromagnetic spectral bands situated in the neighbourhood of wavelengths between 0.5 and 3 mm.

France has taken part in the Russian programme Mars-96. The planet Mars is a major objective for the exploration of the solar system. It manifests certain resemblances to Earth, as well as marked differences.

The Mars-96 mission, for which the Russian Federation is responsible, was carried out in collaboration with some 20 countries. The launching of the Mars-96 mission was scheduled for November, with an orbiter equipped for about 20 scientific experiments and with two ground stations and two penetrators. The nominal lifetime of the satellite was one terrestrial year. France, along with Germany, was the first partner of the Russian Federation, being the contractor for eight experiments and contributing to the performance of eight others. France provided the system installed aboard the orbiter, which relayed the data obtained from smaller stations placed on the surface of Mars, together with a second relay placed on the American satellite Mars Global Surveyor launched at the beginning of November.

The main scientific objectives of the mission were the global study of the physical parameters of the planet Mars (atmosphere, surface and interior) so as to trace the complex history of its evolution since it was first formed.

The launching in November 1996 was not successful because of a defect in the thrust of the fourth stage of the Russian launcher Proton.

France has also taken part in the INTERBALL programme intended to study the behaviour of plasma in the auroral regions and in Earth's magnetospheric tail. This programme has been carried out in cooperation with numerous countries. The mission includes two satellite couples: one, which is eccentric, placed in a high-apogee orbit (200,000 km), and the other, auroral, launched in August 1996 by the Russian launcher Molnya into an orbit with a lower apogee (20 000 km). The inclination of each couple of satellites is 62.88 degrees. Each of the couples consists of a main Russian satellite and a Czech subsatellite. A complete account of the functioning of the satellites and their payloads shows satisfactory performance as a whole. Conversely, the auroral subsatellite is not functioning properly because of a defect in the solar panels.

7. Life and weightlessness

Scientific and technical missions are continuing within the framework of cooperation with the Russian Federation and the United States.

Life and Microgravity Science mission

Jean-Jacques Favier of the French Atomic Energy Centre was selected as a payload expert to fly aboard the NASA Life and Microgravity Science (LMS) Spacelab Mission in June 1996. The mission programme covered experiments in the life sciences, the physical sciences, basic physics and a series of photographs intended for the study of climates and the environment. Jean-Jacques Favier carried out an experimental programme that included, in particular, several French experiments on solidification in the Advanced Gradient Heating Facility of ESA. He was also both the subject and the experimenter for tests in human physiology aimed at better evaluation of the way in which weightlessness alters the basic physiological functions of humans. He also performed experiments intended to bring better understanding of climate and the environment. In France, the flight was monitored in its entirety from the Toulouse Space Centre, which received visits by scientific teams from Europe.

The LMS mission began on 20 June 1996 and ended on 7 July 1996 (a record time for the length of a shuttle flight). The crew of the Columbia space shuttle consisted of seven persons, one of whom was Canadian.

The human physiology programme, which deals with overall physiological functions under conditions of microgravity, was carried out in an identical fashion by four of the Columbia astronauts. On the ground, the four experimenters immediately simulated the same programme for purposes of comparison over an identical period.

The Cassiopée mission

This mission took place between 17 August and 2 September 1996, with 14 days aboard the Mir space station. The Franco-Russian crew of the Cassiopée mission included Claudie André-Deshays, the first French woman astronaut.

The scientific and technological programme for the mission was carried out in full; it included three life sciences experiments: Physiolab to study the cardiovascular system, Cognilab to study perception mechanisms under microgravity and Fertile to study the development of embryos in vertebrates under conditions of

microgravity, an experiment in physical sciences; Alice 2 to study fluids at the critical points and two technological experiments; Dynalab to measure the level of microvibrations at different places in Mir and Treillis for an analysis of the dynamic behaviour of a mechanical trellis floating in the Mir space station.

The experiments are now being processed and a symposium for the initial examination of the scientific results was held on 19 December 1996. On the technical plane, the Castor experiment has permitted the study and validation in orbit of the dynamic characterization of the structures and principles governing the active damping of vibrations. These techniques will be indispensable for future space missions based on interferometry.

POLAND

[Original: English]

Space activity in Poland is conducted mainly in the following fields:

Space physics;

Remote sensing;

Planetary geodesy;

International cooperation;

Teaching in space sciences.

The main institutions involved in this activity are as follows:

Space Research Center of the Polish Academy of Sciences;

Institute of Geodesy and Cartography;

Astronomical Copernicus Center of the Polish Academy of Sciences;

Warsaw University;

Warsaw University of Technology.

The whole activity in space research in Poland is coordinated by the Committee on Space Research (COSPAR), which is a scientific body that also plays the role of the National Committee of COSPAR.

A. Activities in space physics

This year, Polish activities in space physics have been concentrated in the following fields:

(a) Participation in space missions;

(b) Design and construction of scientific equipment for future experiments in space physics;

(c) Processing of data obtained from previous and current space experiments;

(d) Theoretical investigations and interpretation of observational results in the field of space physics.

1. Space missions

The main space project, in which Polish physicists have been involved this year, is INTERBALL, an international multi-satellite mission, devoted to study the terrestrial magnetosphere and the transfer of energy from solar wind into Earth's magnetosphere. All the satellites of this project, the tail probe (INTERBALL-1), launched on 3 August 1995, its subsatellite Magion-4 and the auroral probe (INTERBALL-2), launched on 29 August 1996, operated by the Institute of Space Research in Moscow, are successfully continuing their mission.

Polish scientists have been participating in four experiments of the mission:

Two on the tail probe: ASPI—to measure the plasma waves and electromagnetic fields along the spacecraft orbit; and the solar X-ray thomograph—photometer RF15-I (the last one was constructed in cooperation with the Czech Republic);

One on the Czech subsatellite Magion-4 of the tail probe: SAS—the plasma wave spectrum analyser;

One on the auroral probe: POLRAD—the radio-spectro-polarimeter to measure electromagnetic auroral kilometric radiation.

All of these instruments continue to deliver a good deal of observational data, which are the subject of cooperative analysis in Polish laboratories. Polish engineers have contributed to the development of instrumentation for all of them.

2. Hardware and software for future experiments

Development of instrumentation for several international space projects is being continued in Poland. Listed below are projects to which Poland contributes:

(a) In the CORONAS-F project (coordinated by the Russian Federation): finished construction and tests (in cooperation with the Rutherford-Appleton Laboratory in the United Kingdom of Great Britain and Northern Ireland) of the solar X-ray photometer RESIK;

(b) In the RELICT-2 project (coordinated by the Russian Federation): flight models for GAS-E and GAZ-E ground support equipment have been built;

(c) In the NASA/ESA mission CASSINI/HUYGENS (launched on 15 October 1997): the thermal properties metre (THP) sensor, built in Poland, which is a part of a United Kingdom surface science package (SAP) experiment, has been installed on the HUYGENS lander to Titan, to measure temperature and thermal conductivity of gases and liquids in Titan's atmosphere and ocean;

(d) In the central European satellite for advanced research (CESAR) project: contribution to the construction of the satellite and development of instrumentation for the experiments designed to measure:

(i) Electric and magnetic fields in plasma (wave diagnostics) (PWP);
(ii) Profiles of the spectral lines of the components of Earth's atmosphere (Fourier spectrometer);
(iii) The monitoring of thunderstorms;

(e) In the International Gamma Ray Astrophysics Laboratory (INTEGRAL) project devoted to measuring the X-ray and gamma ray deep space sources:

(i) Contribution to the gamma imager IBIS (construction of the veto electronics system);
(ii) Contribution to the tests and integration of the main detector of the SPI spectrometer;
(iii) Contribution to the X-ray monitor JEM-X (construction of the ground support electronics);
(iv) Contribution to the software in the INTEGRAL Science Data Center;

(f) In the ROSETTA project—a mission to the comet P/Wirtanen: a contribution to the MUPUS experiment in the penetrator PEN/MUPUS, intended to measure the density, temperature, thermal conductivity and mechanical properties of the cometary nucleus: a pre-laboratory model has been produced; and to the experiment VIRTIS, which will measure the spectra of dust-gas emission, the modelling of infra-red spectra of the dust-gas mixture is being conducted;

(g) In the COMPAS project (Russian Federation)—a satellite to investigate electromagnetic disturbances and the ionospheric plasma: construction of the wave spectrometer operating in the frequency range of 0.1-15 MHz.

3. Data processing and interpretation

Listed below are the Polish contributions to the processing and analysis of space data. Most of them have resulted in publications in international journals:

(a) Analysis of data obtained from ASPI (INTERBALL-1) and SAS (subsatellite of INTERBALL-1);

(b) Analysis of data from the solar X-ray spectrometer on board INTERBALL-1;

(c) Analysis of data on auroral kilometric radiation from POLRAD (INTERBALL-2);

(d) Continued data analysis from the SORS-D experiment on electromagnetic wide-band disturbances (CORONAS satellite);

(e) Cooperation in the analysis of solar X-ray Yohkoh data, for investigations of flare heating, plasma motions in flares and the chemical composition of flare plasma;

(f) Data processing and interpretation of the ULYSSES-GAS experiment on the distribution of interstellar helium.

B. Remote sensing activities

The Polish contribution in the field of remote sensing includes the following activities:

(a) Application of NOAA AVHRR satellite images for the development of an early warning system for drought detection (Curie-Sklodowska Foundation);

(b) Investigations on the use of satellite and meteorological data for determination of soil and vegetation indices used in field simulation models (European Community);

(c) The use of airborne and satellite remote sensing to stratification of agricultural production areas for determination of agricultural land structure using the method of area frame sampling;

(d) The use of the digital terrain model in geometrical and radiometric correction of microwave satellite images with varying relief (European Community and local);

(e) Application of radar data (ERS/SAR) for soil moisture assessment (in cooperation with the European Space Agency; ESA pilot project).

In the area of Earth observation, the present activity at the Space Research Center is focused on the preparation of an experiment with the IR Fourier spectrometer (FTIR) for the CESAR space mission to be launched in the year 2000. CESAR will be a Sun-pointing satellite with the following orbital parameters: perigee—400 km, apogee—1,000 km, inclination—70 degrees and period—98.8 minutes. The FTIR spectrometer is devoted to the investigation of the concentration and spatial distribution of atmospheric trace gases (e.g. CH_4, SO_2, NH_3, NO_2, NO_x and HCl) and natural O_3 in the wavelength band 2-16 μm with spectral resolution 0.1 cm^{-1}.

In connection with space missions, a proposal of combined space and ground-based spectrometric observations of the vertical distributions and column densities of nitric acid and nitric oxide has been advanced. Aspects related in particular to the idea of correlative measurements: geometrical details, simulation of the solar absorption spectra corresponding to different observational geometries and associated retrieval methods have been discussed.

The research has been carried out in collaboration with the Belgian Institute for Space Aeronomy.

C. Activities in satellite geodesy

Poland has undertaken investigations of artificial satellite movement for the purpose of geodesy and geodynamics. Major programmes for orbital calculations are being developed and used as tools. The geodynamic processes of regional and local areas are being investigated within the framework of international scientific programmes such as WEGENER, DOSE and CERGOP. Activities in which Poland has been involved include the following:

(a) Investigations of short periodic oscillations of the ocean level using the data from satellite altimetry;

(b) Analysis of the fundamental coordinate systems and their reciprocal transformation;

(c) Investigation in the area of integration of a satellite (GPS) and inertial navigation systems;

(d) Application of satellite methods for precise navigation at the surface of Earth and in the air;

(e) Construction and investigation of models of the ionosphere and the troposphere for geodetic purposes;

(f) Organization of permanent stations with GPS and laser equipment for geodynamic investigation.

D. International cooperation

Cooperation has continued in the following areas:

(a) COST—agreement on PRIME 1—construction of models of the ionosphere over Europe;

(b) French-Polish cooperation on space research;

(c) Russian-Polish cooperation in ionospheric and magnetospheric studies; participation in the Russian INTERBALL project;

(d) Participation in ESA/NASA projects: INTEGRAL, ROSETTA, CASSINI/HUYGENS;

(e) Progress reports and scientific publications for the international scientific community.

E. Education in space sciences

The following activities in education in space sciences are continuing:

(a) Popular science programmes on Polish radio and television;

(b) Popular science lectures for schoolchildren, amateurs in astronomy, physics and astronautics;

(c) Course lectures for university students;

(d) Presentations and lectures for scientific communities;

(e) Popular science articles in the Polish press (daily, weekly and monthly);

(f) Articles in Polish popular science journals (*Postepy Astronomii*, *Urania*, *Delta*).

There is inter-faculty education at Warsaw University in the field of protection of the environment using remote sensing techniques. Recently, inter-faculty education in the field of space science and technology was introduced at Warsaw University of Technology. Lectures at the master of science level will be conducted in the following areas of specialization: remote sensing, satellite telecommunication, space instrumentation, space physics and its applications, satellite geodesy and navigation. Poland also takes part in the initiative organized under the auspices of the United Nations to educate high-level experts in the field of space science and technology applications.

RUSSIAN FEDERATION

[Original: Russian]

The space activities of the Russian Federation in 1997 were conducted under the Federal Space Programme and also as part of international scientific-technical cooperation and commercial agreements.

The Federal Space Programme in 1997 was directed towards priority tasks relating to the most important areas of the exploration and utilization of outer space for the purposes of developing science and technology and intensifying international cooperation.

These priority tasks include the following:

(a) The implementation of international agreements relating to space projects, including the establishment of the International Space Station (ISS);

(b) The maintenance of a global communications system and the relaying of television programmes throughout the Russian Federation;

(c) The undertaking of basic scientific research in astrophysics, planetology, solar physics and solar-terrestrial interaction;

(d) The performing of experiments on the Mir manned orbital station and research on technologies for the production in space of new materials and high-purity substances;

(e) Monitoring of the natural environment, disaster monitoring and management, and exploration of natural resources;

(f) Provision to various users in the Russian Federation and elsewhere of global high-precision coordinate and time references at any time of day and in all locations;

(g) The development of scientific-technical and technological process stock for future space technology.

In 1997, a total of 45 space objects of various kinds were injected into geostationary orbit, including:

(a) Two manned spacecraft from the Soyuz TM series (Soyuz TM-25 and Soyuz TM-26);

(b) Four unmanned cargo spacecraft from the Progress series (Progress M-34 to Progress M-37);

(c) Twelve satellites from the Cosmos series (Cosmos-2337 to Cosmos-2348);

(d) Six telecommunications satellites (three Gonets-D1 satellites, one Molniya-1 satellite, one KUPON satellite and one Zeya satellite);

(e) One Foton spacecraft for research in the field of space technology and biotechnology and one Resurs-F1M spacecraft for investigation of Earth's natural resources;

(f) Nineteen commercially launched spacecraft: TELSTAR-5, PANAMSAT-5, Iridium (14 spacecraft), Astra-1Zh, FAISAT-2v and Early Bird.

On 25 December 1997, the commercial television and radio-relaying satellite ASIASAT was launched into an unplanned orbit.

The above-mentioned space objects were injected into orbit by 28 launches by Proton, Soyuz, Molniya, Tsiklon, Cosmos and Start-1 carrier-rockets.

MAIN RESULTS

A. Manned space flight programme

The fortieth anniversary of the first launch of an artificial Earth satellite was celebrated on 4 October 1997.

The achievements of Russian cosmonautics have found a fitting symbol in the development of the manned Mir space station, which has been operating in the geostationary orbit for more than 10 years as a permanently functioning scientific research laboratory for experimental investigations in real space conditions.

A series of experiments are currently being performed in the Mir station in the following fields: space technology, geophysics, medicine and biology, Earth's natural resources, environmental science, biotechnology, astronomy, space power engineering and engine design.

In 1997, work connected with the Mir manned scientific research station continued under the programme for the 22nd, 23rd and 24th principal expeditions (EO-22, EO-23 and EO-24), and also under international cooperation programmes conducted jointly with the National Aeronautics and Space Administration (NASA) of the United States of America and the German Space Agency (DARA).

The 22nd principal expedition with a crew of two Russian cosmonauts—Valery Korzun (commander) and Aleksandr Kaleri (flight engineer)—continued its work on board the Mir station from August 1996 and was joined by the United States citizen John Blaha as flight engineer 2 in September 1996.

Atlantis STS-81 returned John Blaha to Earth on 22 January 1997 after a flight under the Mir-NASA-4 Programme which lasted from 15 January to 20 January 1997. He was replaced on board the station by NASA-4 astronaut Jerry Linenger.

The launch of the Soyuz TM-25 craft with the crew of the 23rd principal expedition, consisting of the two Russian cosmonauts Vasily Tsibliev (commander) and Aleksandr Lazutkin (flight engineer) and the German astronaut and research scientist Reinhold Ewald, took place on 10 February 1997.

The crew of the 22nd principal expedition (EO-22), consisting of cosmonauts Valery Korzun and Aleksandr Kaleri and German astronaut and research scientist Reinhold Ewald, was returned to Earth on 2 March 1997 by the Soyuz TM-24 craft.

The 22nd principal expedition lasted 192 days.

The United States astronaut Jerry Linenger continued working on board the Mir station as a member of the crew of the 23rd principal expedition.

In accordance with the scheduled programme, Atlantis STS-84 was launched on 15 May 1997 at 1208 hours and docked with the Mir station on 17 May 1997 at 0639 hours.

The duration of the joint flight by the Atlantis craft and the Mir station was five days, during which the following main operations were performed:

(a) Delivery to the station of the United States astronaut Michael Foale for continuation of the NASA-5 long-duration mission;

(b) Delivery to the station of American scientific instrumentation for the purposes of research, components for the life-support system, Russian instrumentation, including an Elektron oxygen generator unit for the crew, and consumables;

(c) Completion of a joint programme of experiments and research;

(d) The return to Earth of the scientific research results, Russian equipment, including the malfunctioning Elektron unit, and American apparatus and equipment.

On 22 May at 0503 hours Atlantis STS-84 undocked from the Mir station and on 24 May at 1728 hours landed on the landing strip of the Kennedy Space Center in Florida.

The NASA-4 astronaut Jerry Linenger was returned to Earth by Atlantis STS-84. The duration of his flight on board the Mir station had been 134 days.

Michael Foale remained on board the Mir station as a member of the 22nd principal expedition, and as its fifth American astronaut, in order to conduct scientific experiments in the course of a long-duration orbital flight. Thus, NASA astronauts have been working on the Mir station continuously since March 1996.

During the work phase of the 23rd principal expedition, on 25 June, when the Progress M-34 transport craft was approaching the Mir station, a collision occurred between the two craft. As a result, the Spektr module was depressurized and the module's electric power system was cut off from the Mir station's power supply bus, which caused a power shortage on the station and cut off the supply to the Kristall module and the docking module used for docking with the Shuttle orbital craft.

Despite the fairly critical emergency situation on board the station during the first moments after collision with the transport craft, the crew of the 23rd expedition (commander V. Tsibliev, flight engineer A. Lazutkin and flight engineer 2 M. Foale) managed to disconnect the power cables and seal off the air ducts running through the hatch of the Spektr module and prevent loss of pressure using the reserve pressurization system in accordance with the instructions from flight control and to close the hermetic cover of the hatch from within the transfer chamber of the station's base block.

It was determined from the results of the analysis performed that in the collision with the transport craft one of the four solar arrays of the Spektr module and the external radiator of the heat regulation system had been damaged. The precise place in the module's structure where a pressure leak had occurred could not be established and has yet to be ascertained.

Owing to the disconnection of the Spektr module flight systems, the most unfortunate consequence of the accident was the considerable reduction in electric current supply to the station's power supply system, which made it necessary to cut off the power supply to the Kristall and Priroda modules and caused a power shortage on the Kvant-2 module.

Thanks to further power conservation measures on the Kvant-2 module, it was possible by 14 July 1997 to restore a positive power-supply balance.

Structural load evaluations after the collision between the Mir station and the Progress M-34 craft showed that the load-carrying capacity of the docking nodes of the orbital station's modules had not been affected. These evaluations were confirmed by successful docking operations of the Progress M-35 and Soyuz T-26 transport craft with the orbital station.

Repair equipment and instrumentation were delivered by the Progress M-35 transport craft to the station for the purpose of connecting the power supply system of the Spektr module to the station's general power supply system.

In the interests of carrying out a more detailed analysis of the technical conditions of the station's flight systems and on the basis of an objective assessment of the psychological and physical state of the EO-23 crew, decisions were taken to proceed with a "spacewalk" by the crew with the 24th principal expedition into the depressurized Spektr module, with the aim of connecting its solar arrays to the general power-supply system of the station, and to defer the visit of a French astronaut under the Pegasus programme to the mission of the 25th principal expedition, by which time conditions allowing the implementation of special programmes would be restored.

On 14 August 1997, the crew of the 23rd expedition, consisting of cosmonauts V. Tsibliev and A. Lazutkin, was returned to Earth after a flight lasting 185 days.

The 24th principal expedition (EO-24) began its work on board the Mir station with a crew consisting of two Russian cosmonauts, Anatoly Solovev (commander) and Pavel Vinogradov (flight engineer 1), who were delivered on board the Soyuz TM-26 craft on 7 August 1997, and the NASA-5 astronaut and United States citizen Michael Foale (flight engineer 2), who had been a member of the 23rd expedition.

Unlike previous expeditions, whose purpose was to carry out a large volume of research and experimental work, the scheduled programme of work for the 24th expedition includes as a special feature repair and maintenance operations on structural components of the Spektr module.

In 1997 the crew of the 24th principal expedition performed five space walks, in the course of which operations were carried out to repair the power-supply circuit of the Mir station, evaluate the structural condition of the Spektr module at the site of the pressure leak, replace a solar array on the Kvant module and perform various scientific experiments.

These operations resulted in restoration of the normal operation of the Mir station and full working order of all critical life-support systems. In addition, they permitted the delivery on board and installation of the Vozdukh and Elektron supplementary systems.

In accordance with the scheduled programme, on 26 September 1997 at 0634 hours the launch of the Atlantis STS-86 spacecraft took place; it docked with the Mir station on 27 September 1997 at 2357 hours.

The crew of Atlantis STS-86 consisted of seven astronauts, including the Russian cosmonaut V. Titov, the French astronaut Jean-Louis Chrétien and the NASA-6 astronaut David Wolf, who replaced the NASA-5 astronaut Michael Foale on board the Mir station.

The joint flight of the Atlantis craft and the Mir station lasted six days, during which the following main operations were performed:

(a) Approach and docking of the Atlantis craft and the Mir station;

(b) Delivery to the station of an American astronaut for the purpose of carrying out the NASA-6 long-duration mission;

(c) Delivery to the station of cargo, including a Salyut 5 B flight computer and repair equipment (cone) for repairing the pressure leak on the Spektr module;

(d) A joint programme of research and experiments;

(e) The performance of a "spacewalk" by the astronauts from the Atlantis craft for the purpose of removing from the station's docking module American apparatus mounted during the STS-76 flight;

(f) A circling of the station for the purpose of inspecting and documenting any damage and possible pressure-leak sites on the Spektr module using photographic and video equipment;

(g) The return to Earth of the American astronaut from the NASA-5 mission;

(h) The return to Earth of the research findings and the malfunctioning equipment for research under factory conditions.

On 3 October at 2116 hours, Atlantis STS-86 undocked from the Mir station and landed on 7 October at 0155 hours on the landing strip of the Kennedy Space Center in Florida.

The NASA-5 astronaut Michael Foale, who was delivered to the Mir station on board Atlantis STS-84 on 18 May 1997, was returned to Earth on board Atlantis STS-86. His flight on board the Mir station had lasted 144 days.

David Wolf remained on board the Mir station as a member of the 24th principal expedition (EO-24); he is the sixth American astronaut to embark upon a wide-ranging programme of work to be performed during a long-duration orbital flight. There has thus been an unbroken succession of NASA astronauts working on the Mir station since March 1996.

The return of David Wolf is planned to take place on board Endeavour STS-89 at the end of January 1998.

During the mission of the 24th expedition the Mir station docked with the transport craft Progress M-36 (launched on 5 October 1997) and Progress M-37 (launched on 20 December 1997); plans have also been made for docking with the manned transport craft Soyuz TM-27 (launch date 29 January 1998), carrying the three-member crew of the 25th expedition (EO-25), one of the crew members being an astronaut from the Centre national d'études spatiales (CNES) of France.

Various scientific and practical results obtained on the Mir station have had a considerable impact on the development of new technologies with industrial and social applications for the twenty-first century. These include the development of basic technologies for obtaining perfect monocrystals for use in the design of ultra-high-speed radiation-resistant integrated microcircuits, super-high-frequency and laser technology and nuclear radiation detectors; the development of experimental diagnostic antisera for use as standards in the production of flu vaccines; refinement of the technique of growing crystals of various proteins and viruses necessary for the development, by means of genetic engineering, of new medicines to combat oncological diseases, acquired immunodeficiency syndrome (AIDS) and other diseases.

A whole array of practical results obtained during missions on board the Mir station are already being used today in various branches of industry, science and medicine. On the basis of materials produced by space photographic surveys, methods have been developed for soil inventory and for predicting and prospecting for deposits of useful minerals, and a photographic album entitled "Space environmental evaluation methods" has been compiled. Weighted spacesuits with electrostimulators are being used to good effect for medical purposes in clinics. A mobile medical complex has been established for the purpose of providing emergency medical care for disaster victims and is currently being used in relief operations after earthquakes and other catastrophes. Astrophysicists have made a number of important discoveries in their observations of the Supernova. A total

of 10 new X-ray sources have been discovered, a map of X-ray objects at the centre of the Galaxy and the Large Magellanic Cloud has been drawn, and various other scientific data have been obtained.

The continued operation of the Mir complex until the years 1999 and 2000 is worth while because of the presence on board the station of a considerable assembly of fully operational research apparatus of both Russian and foreign manufacture and also because of the necessity that the Russian Federation fulfil its obligations regarding the completion of joint research programmes with foreign partners and the possibility of amassing invaluable experience in the operation of the station and refinement of principles, design-related solutions and technologies for restoring the full working order of long-duration manned stations capable of making an effective contribution to future Russian and international space programmes, including the ISS programme.

B. Applied space technology programmes, communications, television transmission and navigation

1. Space communications, television transmission and navigation

In 1997 the operation of the long-range telephone and telegraph communications system was maintained, as was the relaying of radio and television programmes and the transmission of data on behalf of various official authorities and industrial sectors of the Russian Federation and international communications by means of the Gorizont, Ekspress, Gals and Ekran-M spacecraft.

Under the programme to establish a space data transmission system, three further Gonets-D1 space objects were launched to supplement the three already in orbit.

The year 1997 saw the continued operation of the Global Orbiting Navigation Satellite System (GLONASS), used for navigation by civil aircraft and naval vessels and also by other sectors of industry. There are currently 13 spacecraft from the Cosmos series in orbit as part of GLONASS.

The Nadezhda satellites continued operating within the International Search and Rescue Satellite System (COSPAS-SARSAT), an international system for tracking and rescuing sea vessels and aircraft in distress.

2. Remote Earth sensing, meteorological observation and environmental monitoring

Issues relating to the environment, the rational utilization of natural resources and the establishment of a natural disaster and catastrophe warning system have acquired enormous importance in the world today. Work is being done in this area with a view to the establishment or modernization of satellites designed for high-resolution operational observation of Earth, all-weather observation of the Pacific Ocean and environmental monitoring.

In 1997 there was continued operation of meteorological satellites (Meteor-3 and Elektro), an oceanographic satellite (Okean-01) and a natural-resource monitoring satellite (Resurs-01), together with continued use of data received from foreign satellites (NOAA and Meteosat) and information from the Priroda module, belonging to the Mir orbital station.

In November 1997 the launch took place of the Resurs-F1M satellite, from which photographic observation of Earth has been carried out.

Space data received on a regular basis from the satellites Meteor-3, Elektro, NOAA and Meteosat are used in weather analysis and forecasting. On the basis of data received from the satellites Okean-01, Meteor-3 and

NOAA it has been possible to monitor the ice situation in the Arctic (along the North Sea route) and the Antarctic (during the delivery of goods and new expedition members to Russian Antarctic stations).

In the interests of achieving more accurate forecasts of hazards over areas of inland and landlocked water in the European part of the Russian Federation, regular use has been made of data on the velocity of sea-surface winds and areas of particularly high precipitation on the basis of radiophysical data received from the Okean-01 satellite.

In satellite hydrology, work is currently being focused on environmental research aimed at determining the extent of chronically polluted areas of river basins and at mapping submerged areas along the flood plains of rivers. This work has been based on complex analysis of photographic satellite images, collated with the findings of operational ground-based observations, and mapping and statistical data.

Work continued in 1997 with a view to establishing future space technology for different purposes, namely hydrometeorological observation (the Meteor-3M satellite) and operational land and ocean observation (the Okean-0 satellite), both of which are scheduled to be launched in 1998.

3. Space technologies

Studies in the sphere of space technology and the physics of weightlessness were directed towards the production under microgravity conditions of new organic and inorganic materials and the refinement of the technologies and equipment required for their production, including commercial production. The use for these purposes of both manned and unmanned spacecraft has made it possible to grow crystals with properties which are unobtainable on Earth, thus providing the requisite scientific and technical process stock for the transition to the experimental industrial production of materials in space. The main purpose of establishing the planned space assembly is to complete the development of basic technologies for producing test parts for semiconductors, "gradans" and other preparations with practical industrial applications.

The space technology programme is being conducted by means of the Foton spacecraft (launched on 9 October 1997) with the participation of European Space Agency (ESA) member States. Semiconductor materials produced under microgravity conditions (cadmium telluride, gallium arsenide, zinc oxide, silicon etc.) have properties representing an improvement on their Earth counterparts by a factor of 50-70. The biological preparations obtained are 5-10 times purer than their Earth counterparts.

Work is under way to design a new generation of spacecraft in order to continue research under microgravity conditions. The new spacecraft are being designed to have an active life 10 times longer than that of the Foton. Plans are being made to use these craft to refine the basic technologies for the production of semiconductors, "gradans" and biological preparations with practical industrial applications.

C. Space research programmes

Fundamental research on celestial bodies and outer space contributes to humankind's knowledge of the Universe, the processes at work in it and their impact on Earth. Such research will assist future human endeavours in space and on the celestial bodies and will provide a basis for manned flights to Mars in the new millennium.

The Russian Academy of Sciences plans to use space technology in conducting more detailed study of high-energy space particles and of solar-terrestrial interaction, the development of a heliogeophysical monitoring system being planned for the future. It intends to carry out complex research of Earth's

magnetosphere and to study the interaction of processes on the Sun and in the circumterrestrial plasma with life on Earth.

A programme of flight experiments has been successfully conducted at the Granat orbital observatory. During its eight years of operation, a detailed study has been made of several dozen galactic and extra-galactic sources, representing possible black holes, neutron stars (X-ray bursters and X-ray pulsars), X-ray novae and accumulations of galaxies and quasars; a number of interesting and hitherto unknown objects have been discovered. For the first time, sources emitting radiation in the annihilation gamma line of positronium have been localized. The observatory is currently operating in the scanning regime and is continuing to transmit valuable information.

Solar research is of exceptional scientific importance. The Sun is the principal source of energy and the "generator" of all the main natural processes on Earth and in cirumterrestrial space. Furthermore, it is the star most accessible to study, being observable from Earth as an extended object.

The Sun and its corona provide, essentially, a vast natural laboratory for the study of fundamental properties of substances in the plasma state. Research conducted on spacecraft from the Automated Universal Orbital Station (AUOS) series using new configurations of scientific instrumentation are substantially improving the understanding of the mechanisms of solar flare activity and are making it possible to locate the active parts on the Sun's surface and to identify phenomena reliably heralding flares.

All of this provides a basis for reliable forecasting of solar activity. A different area of research is the processing of the valuable information yielded with a view to identifying meaningful patterns.

Under the INTERBALL programme (two satellites from the Prognoz-M2 series), a system has been set up in space for conducting long-term fundamental research on processes taking place under the influence of solar radiation in Earth's magnetosphere. This research forms an integral part of the international programme for investigating the nature and mechanisms of solar-terrestrial interaction by means of spacecraft and ground-based observatories in various countries.

The Prognoz-M2 satellite has been fitted with scientific instruments designed by scientists and specialists from the Russian Federation, from Austria, Bulgaria, Canada, Cuba, Czech Republic, Finland, Germany, Greece, Hungary, Italy, Kyrgyzstan, Poland, Romania, Slovakia, Sweden, Ukraine, United Kingdom of Great Britain and Northern Ireland and Uzbekistan, and also from ESA.

The results of the research are extremely promising, since the investigation and identification of patterns and mechanisms of interaction in the behaviour of the Sun and circumterrestrial plasma will provide a key to a closer understanding of the "secret" of life on Earth.

Work is currently under way in the field of astrophysics in connection with the Spektr-RG project (high-energy research) and the Spektr-R project (development of a fundamentally new area of research on astrophysical objects by means of very long base radiointerferometry (i.e. using a base greater than Earth's diameter).

D. International cooperation

One of the most important components of the Russian space programme today is international cooperation.

The international cooperation efforts of the Russian Federation are being deployed in virtually all areas of its national space programme, including:

(a) Implementation of a programme of manned flights; participation in the large-scale joint scientific and technical project to establish ISS;

(b) Use of Russian carrier rockets for launching foreign satellites;

(c) Study of Mars, including, in particular, participation in the United States project Mars-98 (installation on board the craft of two Russian instruments);

(d) Use of the global navigation satellite system (the Russian system GLONASS and the American Global Positioning System (GPS));

(e) In the area of microgravity, implementation of the Foton project with the participation of ESA, CNES and the German Aerospace Research Establishment (DLR);

(f) Development of COSPAS-SARSAT, the international tracking and rescue system;

(g) Photography and exchange of remote Earth sensing data, in particular those data received from the Russian Resurs satellites and the French Système pour l'observation de la Terre (SPOT) satellite;

(h) Contractual assignments in the sphere of research and development, fundamental research, experimental and ground-based trials to ensure the future development of space and rocket technology;

(i) Cooperation with member States of the Commonwealth of Independent States (CIS) under an inter-State programme for the exploration and use of outer space.

The Spektr programme of astrophysical space research is the international and national space programme assigned top priority in the field of fundamental research. In addition to institutes of the Russian Academy of Sciences and Russian companies and organizations in the rocket and space sector, organizations and companies from 20 other countries are involved in the execution of this project.

New and even more favourable conditions for the implementation of international space agreements are being created in the Russian Federation with a view to developing international cooperation, including cooperation within the context of the world commercial space market. Inter-State and intergovernmental agreements on cooperation in the sphere of space activities have been concluded with a large number of countries. The Russian Space Agency has also signed agreements with the space agencies of 13 countries, ESA and the International Space University.

A number of joint ventures with foreign firms have been established by enterprises in the rocket and space sectors of industry.